TOPIC 08 – ACIDS/BASES
8.4 – PH SCALE

IB Chemistry

T08D03

8.4 The pH scale - 1 hour

- 8.4.1 Distinguish between aqueous solutions that are acidic, neutral or alkaline using the pH scale. (2)
- 8.4.2 Identify which of two or more aqueous solutions is more acidic or alkaline using pH values. (2)
- 8.4.3 State that each change of one pH unit represents a 10-fold change in the hydrogen ion concentration [H+(aq)]. (1)
- 8.4.4 Deduce changes in [H+(aq)] when the pH of a solution changes by more than one pH unit. (3)

8.4 – pH Scale is Log_{10} based

- As scientists we don't like really big or really small numbers. So we use scientific notation. When that gets a bit tiresome, we go even further.
- Sorensen proposed the pH scale to simplify the comparison of concentrations of H^+ ions in solution
- The pH scale is base on the log_{10} scale
  - Review: if $Log_2 8 = x$, *then x would equal 3*
  - $Log_{10} 100 = 2$
  - So the base 10 logarithm scale is simply an exponential scale (scientific notation) written in a different form

8.4 – pH Scale

- When dealing with acids and bases in chemistry we often deal with very small concentrations of $[H^+]$ and $[OH^-]$ ions that range from $1x10^0$ to $1x10^{-14}$
- Instead of using these small values, we break it down into the $\log_{10}$ scale from 0-14
  - If $[H^+] = 1x10^0$ M, then $Log_{10}1 = 0$
  - If $[H^+] = 1x10^{-1}$, then $Log_{10}0.1 = -1$
  - If $[H^+] = 1x10^{-2}$, then $Log_{10}0.01 = -2$
  - If $[H^+] = 1x10^{-3}$, then $Log_{10}0.001 = -3$

BUT, we don't want negative values, so we simplify

- Instead of $\log[H^+]$ we use the NEGATIVE $-\log[H^+] = pH$

pH	$[H^+]$ ions in scientific notation	$[H^+]$ ions traditionally
0	$1x10^{0}$	1.0
1	$1x10^{-1}$	0.1
2	$1x10^{-2}$	0.01
3	$1x10^{-3}$	0.001
4	$1x10^{-4}$	0.0001
5	$1x10^{-5}$	0.00001
6	$1x10^{-6}$	0.000001
7	$1x10^{-7}$	0.0000001
8	$1x10^{-8}$	0.00000001
9	$1x10^{-9}$	0.000000001
10	$1x10^{-10}$	0.0000000001
11	$1x10^{-11}$	0.00000000001
12	$1x10^{-12}$	0.000000000001
13	$1x10^{-13}$	0.0000000000001
14	$1x10^{-14}$	0.00000000000001

8.4 – pH Scale

- Find pH from H^+
  - **$pH = -log[H^+]$**
- Find H^+ from pH
  - **$[H^+] = 10^{-pH}$**
- **pH<7 ACIDIC**
- pH=7 NEUTRAL
- **pH>7 BASIC**
- pH(1) 100x more acidic than pH(3)
- pH(6) is 10,000x more basic than pH(2)

8.4 – pOH Scale

pH	pOH	[OH-] ions in scientific notation	[OH-] ions traditionally
0	14	$1x10^{-14}$	0.00000000000001
1	13	$1x10^{-13}$	0.0000000000001
2	12	$1x10^{-12}$	0.000000000001
3	11	$1x10^{-11}$	0.00000000001
4	10	$1x10^{-10}$	0.0000000001
5	9	$1x10^{-9}$	0.000000001
6	8	$1x10^{-8}$	0.00000001
7	7	$1x10^{-7}$	0.0000001
8	6	$1x10^{-6}$	0.000001
9	5	$1x10^{-5}$	0.00001
10	4	$1x10^{-4}$	0.0001
11	3	$1x10^{-3}$	0.001
12	2	$1x10^{-2}$	0.01
13	1	$1x10^{-1}$	0.1
14	0	$1x10^{0}$	1.0

- Find pOH from OH^-
  - **$pOH = -log[OH^-]$**
- Find OH^- from pOH
  - **$[OH^-] = 10^{-pOH}$**
- **pOH<7 BASIC**
- pH=7 NEUTRAL
- **pH>7 ACIDIC**
- **pH + pOH = 14**
- **$[H^+][OH^-] = 1x10^{-14}$**

8.4

Concentration of Hydrogen ions compared to distilled water	pH	Examples of solutions and their respective pH
1/10,000,000	14	Liquid drain cleaner, Caustic soda
1/1,000,000	13	bleaches, oven cleaner
1/100,000	12	Soapy water
1/10,000	11	Household Ammonia (11.9)
1/1,000	10	Milk of magnesium (10.5)
1/100	9	Toothpaste (9.9)
1/10	8	Baking soda (8.4), Seawater, Eggs
0	7	“Pure” water (7)
10	6	Urine (6) Milk (6.6)
100	5	Acid rain (5.6) Black coffee (5)
1,000	4	Tomato juice (4.1)
10,000	3	Grapefruit & Orange juice, Soft drink
100,000	2	Lemon juice (2.3) Vinegar (2.9)
1,000,000	1	Hydrochloric acid secreted from the stomach lining (1)
10,000,000	0	Battery Acid

8.4 – Properties of Water

- Water is neutral, duh!!
- It's neutral because it has equal amounts of both
  - $[H^+] = 1x10^{-7}$
  - $[OH^-] = 1x10^{-7}$
  - pH = 7
  - pOH = 7
- This allows us to use water as a reference point
  - $pH + pOH = pK_w$
  - $[H^+][OH^-] = K_w$

8.4 – pH vs pOH

- You now have the ability to convert between any of the four, pH, pOH, H^+, and OH^-
- We now have a way to relate pH and pOH
  - $pH + pOH = pK_w = 14$
  - $[H^+][OH^-] = K_w = 1x10^{-14}$
  - $-\log[H^+] = pH$
  - $-\log[OH^-] = pOH$
  - $10^{-pH} = [H^+]$
  - $10^{-pOH} = [OH^-]$

8.4 – pH Probe and meter

- pH meter is used to measure pH
- The voltage difference is measured between the acid inside the bulb and that outside. This is converted into a pH reading by the meter